# Space Weather Technical Forecast

Issued on Tuesday, 18 January 2022 at 12:27 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Slight Chance of G1, mainly Thursday 20 January from 16 January CME. Chance of isolated M-class flares (R1/R2 radio blackouts) throughout.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Low through the UTC day of Monday 17 January. X-ray activity measured at GOES 17 saw a double-peak long-period C2.8 X-ray flare from sunspot region AR2930 at 17/1414UTC, potentially triggering an adjacent filament lift-off peaking at C2.7 at 17/1516UTC. The ejecta from this event was clearly visible in coronagraph imagery to end the UTC day, angled above and ahead of the Earth in its orbit. This was the only Coronal Mass Ejection (CME) event of note visible in coronagraphs for the period. There are now five active regions on the visible disc. AR2929, AR2930 and AR2933 are the most noteworthy regions being bipolar with two stable unipolar regions. The C2 flare from AR2929 on 16 January produced a CME directed mainly to the northwest. This may pass Earth as a glancing blow early on Thursday 20 January.

**Solar Wind / Geomagnetic Activity:** The solar wind, as measured by DSCOVR and ACE at L1 was symptomatic of connection to a high speed stream, thought to be that emanating from CH44/-. The solar wind speed was elevated and near-level at 550km/s, with a brief lull to nearer 500km/s seen during the early UTC evening. The solar wind density was near or slightly above normal. The IMF was mainly near 5nT but with a peak to 8nT, noted just before midnight while the north-south component varied between -7 and +6nT. The phi angle was mainly negative (towards the sun) but with some brief forays into a positive sector.
The net result of the above solar wind measures was provisionally Quiet to Unsettled (Kp2-3) geomagnetic activity with a Minor Geomagnetic Storm/G1 (Kp5) observed between 18/0000 UTC and 18/0300 UTC

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) measured at GOES 16 remained at Background levels throughout. High energy electron flux (greater than 2MeV) measured at GOES 16 was at Moderate to High levels in the diurnal cycle, with a peak value of 2020pfu at 17/1855UTC. Electron fluence initially rose then remained flat over the 24 hours, with an 18/0000UTC observed value of 8.94e7 integrated pfu recorded.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is likely to be Low with further C-class flares likely a daily Chance of M-class flares

**Solar Wind / Geomagnetic Activity:** The CME from the C2 flare from AR2929 on 16 January may carry an Earth-directed component, with a possible glancing blow arriving early in the UTC day of Thursday 20 January. This gives perhaps a Slight Chance of G1 otherwise, the only coronal hole feature due in the four days is expected to be the current one, CH44. A gradual decline toward a slow regime is therefore expected from midweek, with (excepting the 16 January transient) increasingly Quiet geomagnetic activity expected from an initial Chance of

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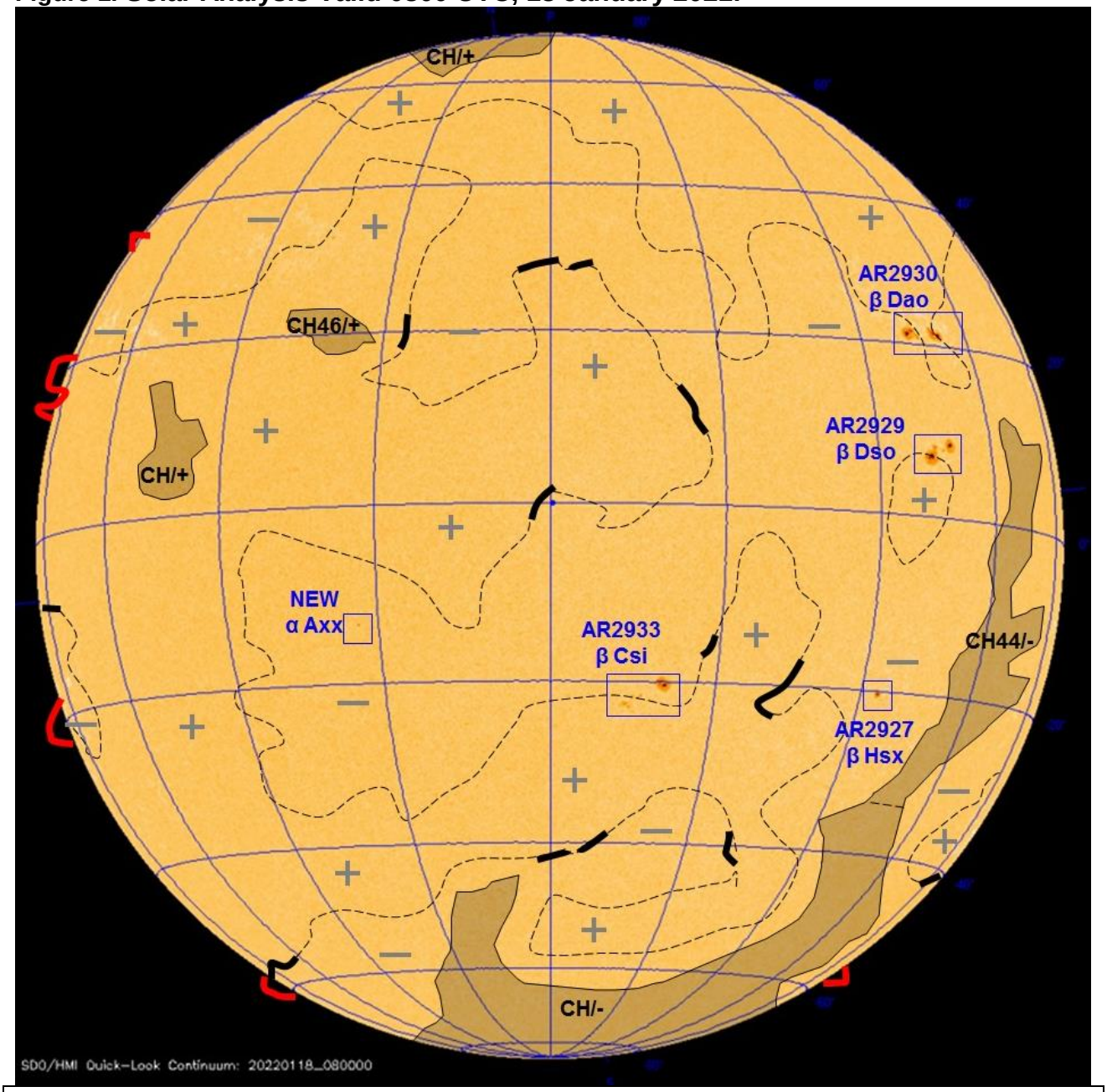
Active or G1.

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels.
The high energy electron flux (greater than 2MeV) is expected to be stabilising, with a current oscillation between Moderate and High flux expected to continue. This puts 24-hour fluence as marginal for surpassing the Active threshold, but perhaps remaining just below, and hastening should the 16 January CME arrive.

**Figure 1. Solar Analysis Valid 0800 UTC, 18 January 2021.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

The CME from the C2 flare from AR2929 on 16 January is now considered to perhaps carry an Earth-directed component, as suggested by some MOSWOC Enlil Ensemble members. These point towards arrival early in the UTC day of Thursday 20 January, with a resultant Slight Chance of G1 proffered, but with low confidence. This analysis exclusively considered the portion of ejecta seen heading northwest on Lasco coronagraphs (also correlated with STEREO A COR2 data). There were also hints of material seen heading north and northeast on Lasco C2 at the same time - the attribution for these streams is not clear, however it is possible that they were produced in the same event, and this was therefore more of a partial halo CME. This uncertainty has influenced the inclusion of the northwestward portion in the forecast as a Slight Chance of G1, however it remains that confidence is low for the event as a whole.

The only coronal hole feature due in the four days is expected to be the current one, CH44, which is now mature, with resultant geomagnetic activity very likely to have already peaked. A gradual decline toward a slow regime is therefore expected from midweek, with no further enhancements (barring the above transient) expected.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 1 | 20 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 17/0235 UTC | Partial? | C2 flare from AR2926 on 16 January | NW quadrant | 562 km/s | 20/0000 UTC | Low confidence, glancing blow |

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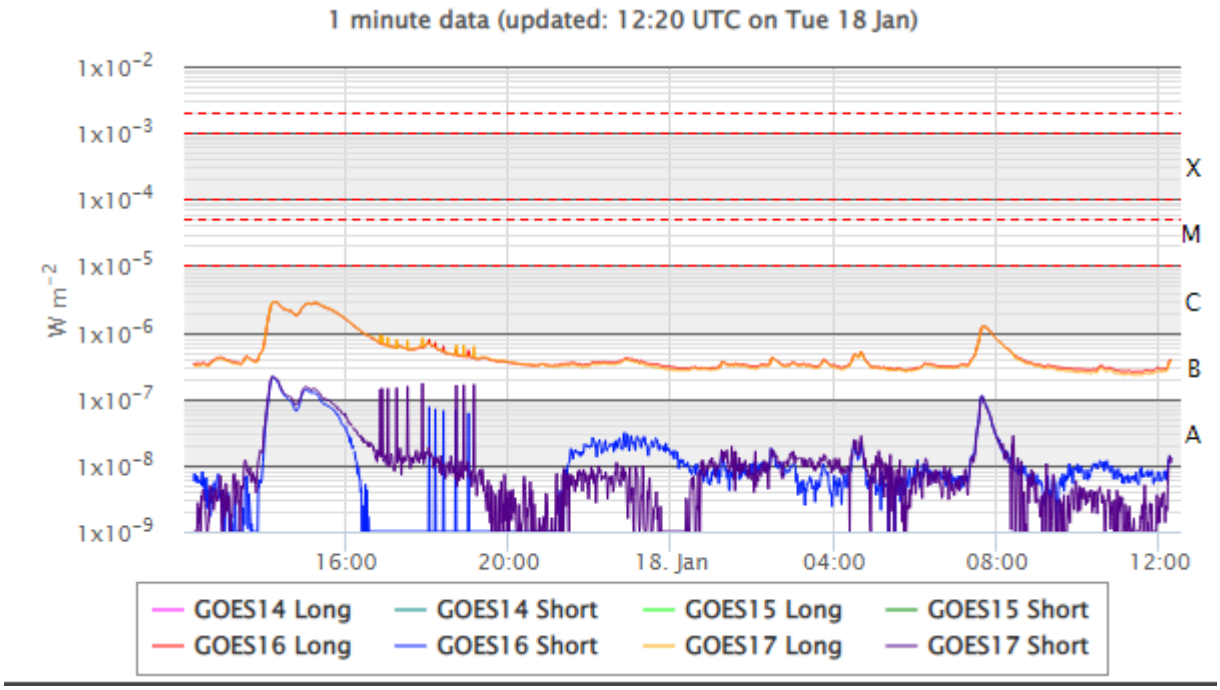
**Radio Blackouts - X-Ray Flares:**
The overall trend in the front-sided sunspot groups has been of stability or slight decline in the past 24 hours, with recent activity confined to low C-class. The more significant regions on the disc all occupy various positions in the western hemisphere and there is little prospect of significant returning regions arriving over the eastern limb in the four-day period to bolster the risk of flares, from available imagery. Relative to recent guidance, the daily risk of M-class flares has been revised downwards.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Active | R1-R2 M Class | No | 20 | 20 | 15 | 15 |
| Very Active | R3 to R5 X Class | No | 1 | 1 | 1 | 1 |

**Figure 2: GOES X-ray flux showing C-class flares in past 24 hours.**

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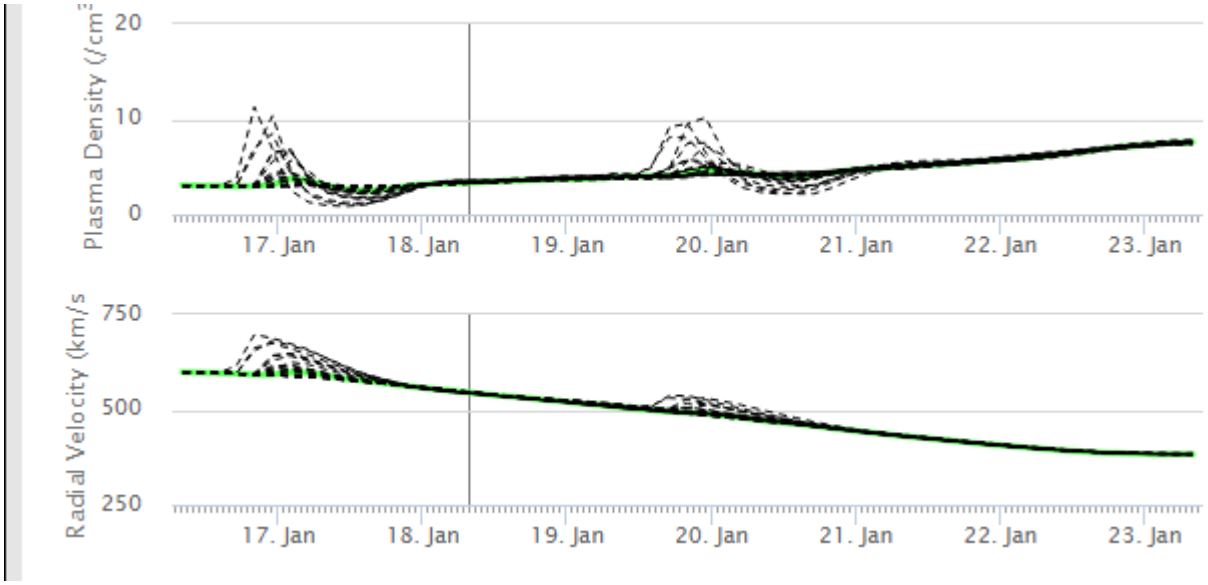
**Solar Radiation Storms - (High Energy Protons):**

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 remains at Background levels. The weight of sunspot groups and activity in the western solar hemisphere is leading to a raised risk of S1 in the coming four-day period, although the effect is very slight.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 2 | 2 | 2 | 2 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

**Figure 3: Met Office ENLIL Ensemble showing likely time of arrival from CME that left the sun on 16 January 2022.**

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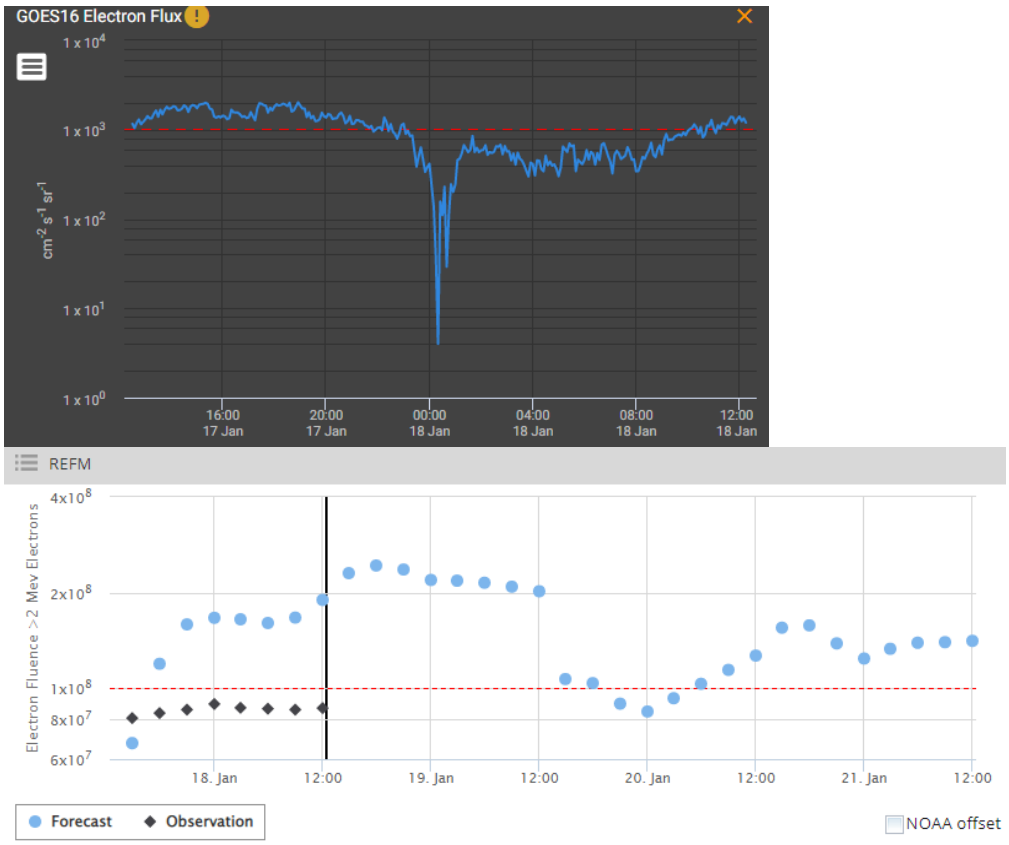
**High Energy Electrons Event (≥ 2MeV):**

High energy electron flux (greater than 2MeV) saw a roughly equal amplitude diurnal oscillation in the past 24 hours to the preceding 24, indicating that the response to the ongoing high speed stream from coronal hole 44 may now be mature. 24-hour integrated fluence remains very near the Active threshold, however on balance may be considered most likely to turn narrowly short of the mark and ebb away in the ambient solar wind conditions expected to follow later this week. Confidence drops markedly with the potential complication of the 16 January CME passing Earth on Thursday 20 January.

The current level of response in high energy electrons is very similar to that seen on last rotation in reaction to CH44's predecessor. REFM is considered to be offering good guidance at present, which gives an almost level trend near to the 1e8 threshold.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 40 | 40 | 20 | 10 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 4: High energy electron flux at GEO and Met Office REFM output (lower plot).**

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